

## Claims

- [c1] A method for calibrating a well-logging sensor, comprising:  
emitting a first signal into a first calibration substance disposed proximate to the sensor;  
measuring a first sensor response from the first signal;  
emitting a second signal into a second calibration substance disposed proximate to the sensor;  
measuring a second sensor response from the second signal; and  
determining a sensor response function from the first sensor response and the second sensor response.
- [c2] The method of claim 1, wherein the sensor response function is a linear function.
- [c3] The method of claim 1, wherein the well-logging sensor is a density sensor.
- [c4] The method of claim 3, wherein one of the first calibration substance and the second calibration substance is an aluminum alloy.
- [c5] The method of claim 3, wherein one of the first calibration substance and the second calibration substance is a magnesium alloy.
- [c6] The method of claim 1, wherein the well-logging sensor is a neutron sensor.
- [c7] The method of claim 6, wherein the neutron sensor is surrounded by water and the first and second calibration substances are disposed in a channel within the neutron sensor.
- [c8] The method of claim 7, wherein one of the first calibration substance and the second calibration substance is air.
- [c9] The method of claim 7, wherein one of the first calibration substance and the second calibration substance is a polymer rod having a known effective porosity.
- [c10] The method of claim 1, further comprising:  
determining an expected range for a quality check response of a quality-check

substance;  
emitting a quality check signal into the quality-check substance disposed proximate to the sensor;  
measuring the quality check response from the quality check signal and  
comparing the expected range with the quality check response.

[c11] The method of claim 10, wherein the quality-check substance is water.

[c12] A method for calibrating a well-logging sensor, comprising:  
emitting a first signal into a first calibration substance disposed proximate to the sensor;  
measuring a first sensor response from the first signal;  
emitting a second signal into a second calibration substance disposed proximate to the sensor;  
measuring a second sensor response from the second signal; and  
emitting a third signal into a third calibration substance disposed proximate to the sensor;  
measuring a third sensor response from the third signal; and  
determining a sensor response function from the first sensor response, the second sensor response, and the third sensor response.

[c13] A method for calibrating a well-logging sensor, comprising:  
providing a well-logging sensor having a known response function;  
determining an expected range of a quality check response of the sensor using a quality-check substance with known properties;  
emitting a quality check signal into the quality-check substance disposed proximate to the sensor;  
measuring the quality check response from the quality check signal; and  
comparing the expected range with the quality check response.

[c14] The method of claim 13, wherein the sensor is calibrated using at least one calibration substance, and the quality-check substance is different from the at least one calibration substance.

[c15] The method of claim 14, wherein the quality-check substance is water.

- [c16] A method for calibrating a well-logging density sensor, comprising:  
emitting a first gamma ray signal into an aluminum alloy block disposed proximate to the sensor;  
measuring a first density sensor response from the first gamma ray signal;  
emitting a second gamma ray signal into a magnesium alloy block disposed proximate to the sensor;  
measuring a second density sensor response from the second gamma ray signal; and  
determining a density sensor response function from the first density sensor response and the second density sensor response.
- [c17] The method of claim 16, wherein the density sensor response function is linear.
- [c18] The method of claim 16, further comprising:  
determining an expected range for a quality check response using water as a quality-check substance from the density response function;  
emitting a quality check gamma ray signal into the water disposed proximate to the density sensor;  
measuring the quality check response from the quality check gamma ray signal;  
and  
comparing the expected range of the quality check response with the quality check response.
- [c19] A method for calibrating a well-logging density sensor, comprising:  
emitting a first gamma ray signal into an aluminum alloy block disposed proximate to the sensor;  
measuring a first density sensor response from the first gamma ray signal;  
emitting a second gamma ray signal into a magnesium alloy block disposed proximate to the sensor;  
measuring a second density sensor response from the second gamma ray signal;  
emitting a third gamma ray signal into water disposed proximate to the sensor;  
measuring a third density sensor response from the third gamma ray signal;  
and

determining a density sensor response function from the first density sensor response, the second density sensor response, and the third density sensor response.

[c20] A method for calibrating a well-logging neutron sensor, comprising:  
emitting a first neutron signal with air disposed in a channel within the sensor;  
measuring a first neutron sensor response from the first neutron signal;  
emitting a second neutron signal with a polymer rod disposed in the sensor channel;  
measuring a second neutron sensor response based on the second neutron signal; and  
determining a neutron sensor response function from the first neutron sensor response and the second neutron sensor response.

[c21] The method of claim 20, wherein the neutron sensor response function is linear.

[c22] The method of claim 20, further comprising:  
determining an expected range for a quality check response from the neutron sensor response function;  
emitting a quality check neutron signal with water in the sensor channel;  
measuring the quality check response from the quality-check signal; and  
comparing the expected range of the quality check response with the quality check response.

[c23] A method for calibrating a well-logging neutron sensor, comprising:  
emitting a first neutron signal with air disposed in a channel within the sensor;  
measuring a first neutron sensor response from the first neutron signal;  
emitting a second neutron signal with a polymer rod disposed in the sensor channel;  
measuring a second neutron sensor response based on the second neutron signal; and  
emitting a third neutron signal with water disposed in the sensor channel;  
measuring a third neutron sensor response based on the third neutron signal;  
and  
determining a neutron sensor response function from the first neutron sensor

response and the third neutron sensor response.

- [c24] A method of calibrating a well-logging sensor, comprising:
- emitting a signal into each of at least two calibration substances disposed proximate to the sensor;
  - measuring at least two sensor responses corresponding to the signals emitted into said disposed calibration substances; and
  - determining a sensor response function from the at least two sensor responses.